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# Initial Thoughts on Cavity Processing Facility

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# Introduction



- In 2006-07 Fermilab made a plan for a cavity processing facility to be built at Fermilab.
- That program was reviewed by DOE and other committees
  - It did receive positive recommendations
- But, We have not made much progress on it
  - Due to resource limitations
  - Due to lack of consensus on what to do and how to proceed
- In this discussion I am presenting the current situation with cavity processing in US, Fermilab's need and A possible plan.
  - We need to discuss this openly and start working on a plan that can be executed

# US Cavity Processing Capabilities

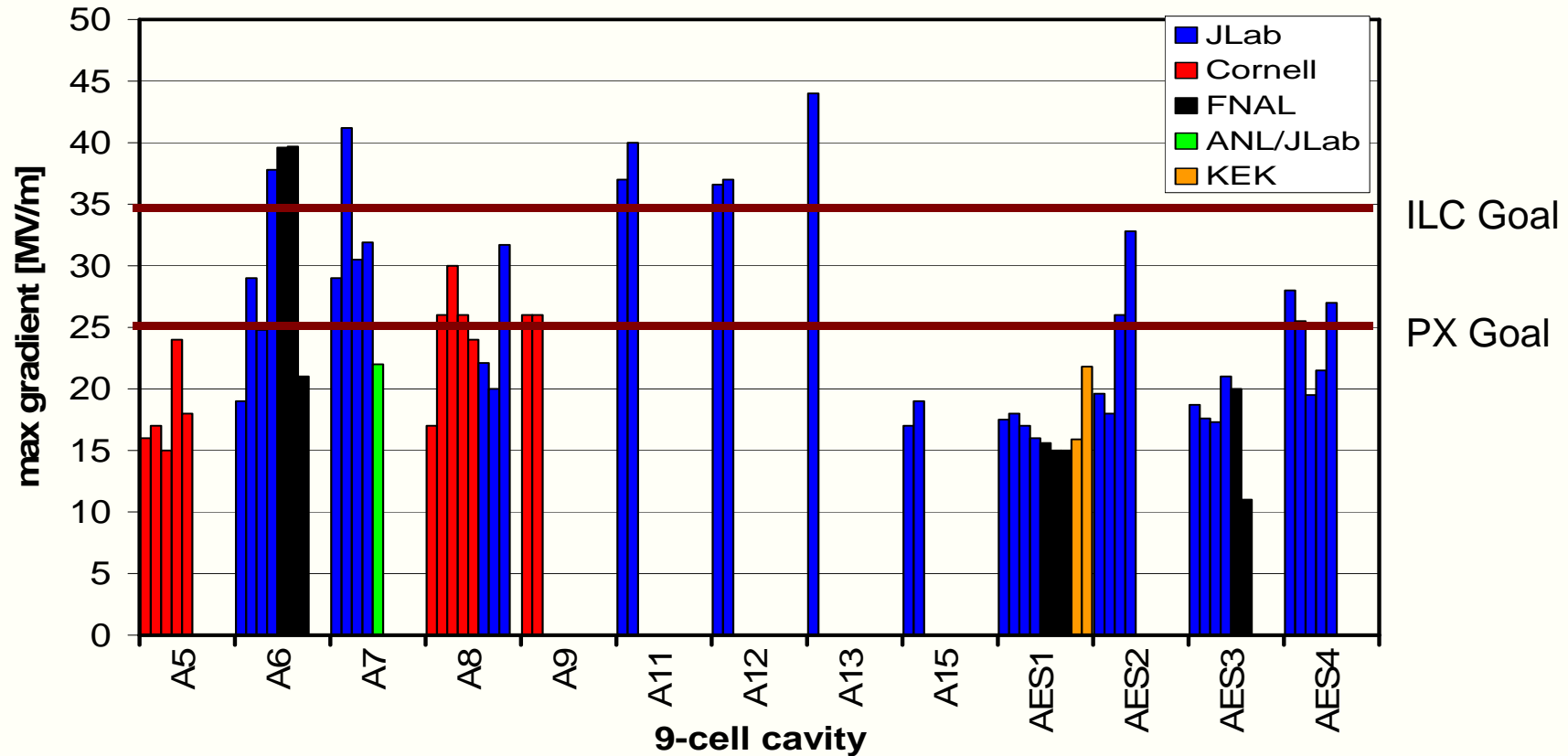


- **Fermilab in collaboration with Jlab, ANL and Cornell is processing 1.3 GHz and Spoke Resonator cavities.**
- **Jlab facility is quite mature and has established itself in producing excellent**
  - **Reproducible high gradient**
  - **Small or no field emission**
  - **Backed by cavity and sample R&D**
- **ANL facility is in the last stage of commissioning**
  - **Fermilab is integral part of this facility operation**
  - **Recent 1-cell test have shown excellent result with no field emission**
  - **It will be backed by cavity and sample R&D both at Fermilab and ANL**
- **Cornell facility is an R&D facility**
  - **It uses vertical EP**
  - **It has not produced a 9-cell cavity with >30 MV/m**
- **Fermilab is in process of building a cavity processing R&D facility**

# Jlab EP Facility



# Results from US Cavity Processing



Mostly Jlab Processing

# Fermilab-Argonne Cavity Processing Facility



- Provides complete processing of 1.3 GHz cavities:
  - electro-polishing, ultrasonic cleaning, high-pressure rinse, assembly, etc.
  - Facility nearing completion (HPR, ultrasonic, fixtures)
- This has taken a long time...
  - Progress has been mostly limited by available FNAL M&S funds and labor
  - Stopped all work Dec 07 to May 08, M&S purchases with supplemental funds
  - Still NEED serious FNAL horsepower on this! (not a huge number of people)



- Three single-cell cavities and one 9-cell cavity electro-polished so far
- Optimization in progress



**New Ultrasonic cleaning system**



**New High-pressure rinse system**

# 1-cell Processing Test at ANL

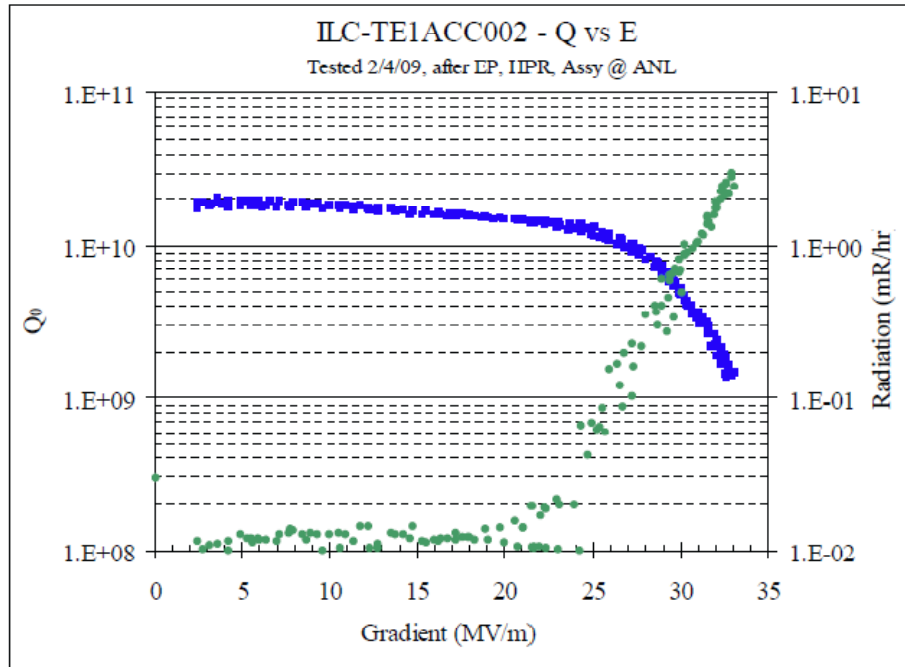


Figure 1.)  $Q_0$  vs E run at 2K

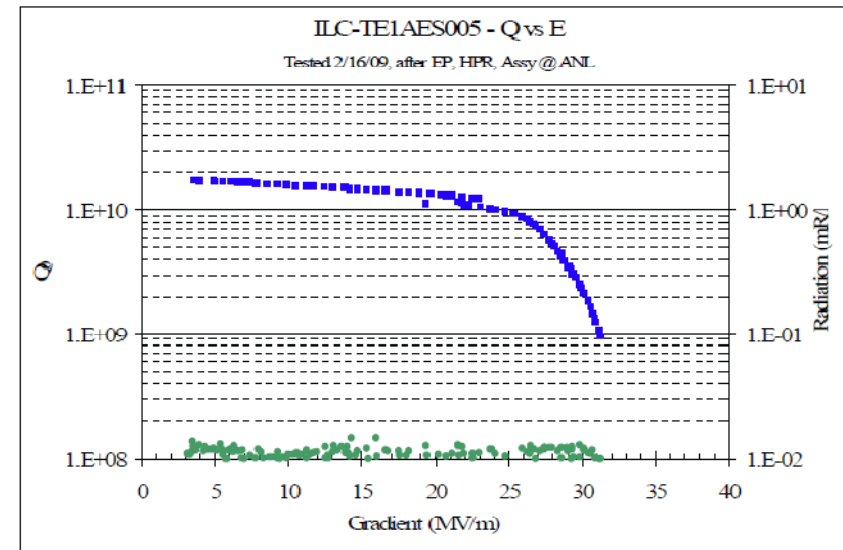


Figure 1.) Initial  $Q_0$  vs E run at 2K

# Present US Cavity Processing Capacity



- **Process cycle:- One bulk (150 micron) and one fine (20 micron) processing with bake, HPR, tuning and one vertical test.**
- **Advertised Jlab processing facility capability is 40 process cycle per year.**
  - **We have not tested this**
  - **This facility has no redundancy and is taken down for routine maintenance, stopping the processing**
- **Advertised ANL processing facility capability is also 40 process cycle per year**
  - **We have not tested this**
  - **This facility has no redundancy and is taken down for routine maintenance, stopping the processing**
  - **This facility operates (or will) in concert with Fermilab facility of tuning, bake and vertical test**
- **Cornell's facility can maximum handle 10 process cycle per year and should only be considered as an R&D facility.**



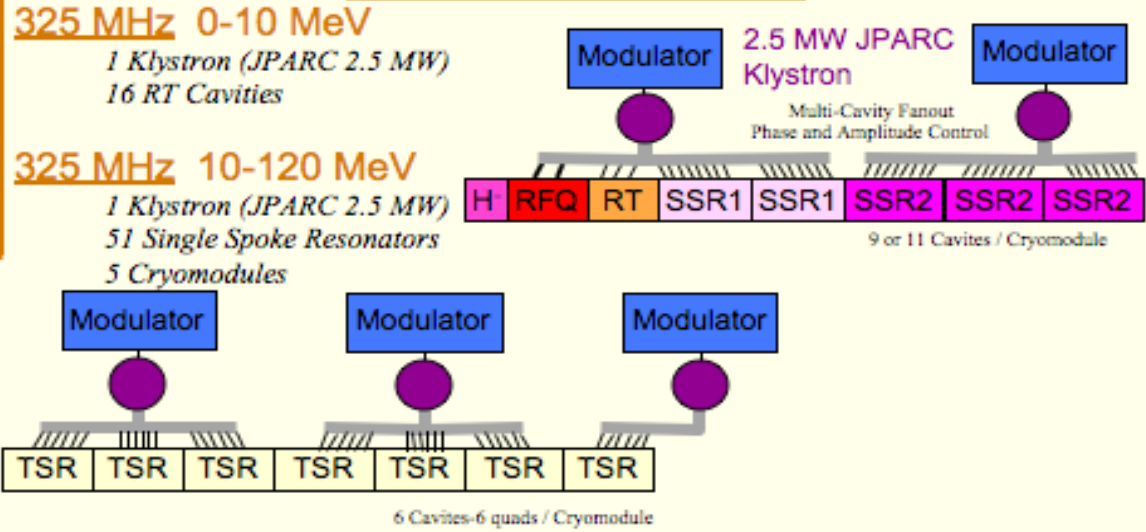
# Project X: Needed Capacity



ab

**Project X**  
**1000 kW 8GeV Linac**  
 28 Klystrons (2 types)  
 461 SC Cavities  
 58 Cryomodules

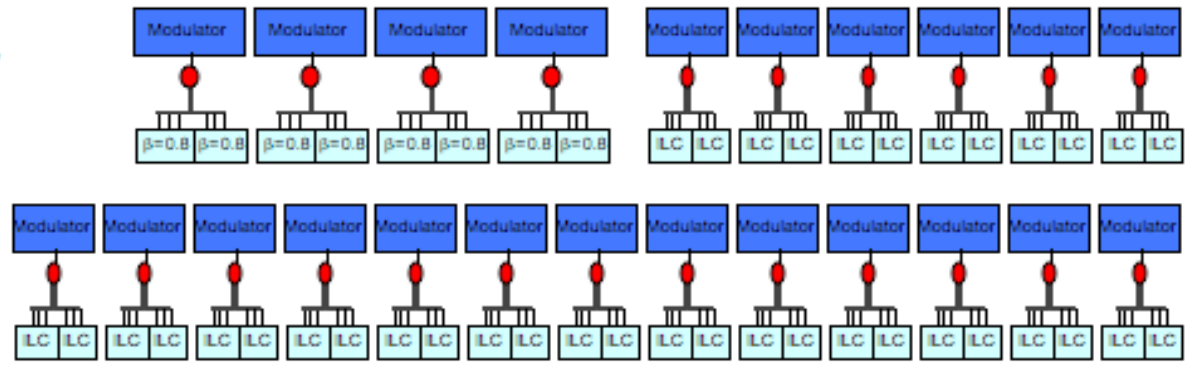
## Front End Linac



## 1300 MHz LINAC

**1300 MHz 0.42-1.3 GeV**  
 4 Klystrons (ILC 10 MW MBK)  
 64 Squeezed Cavities ( $\beta=0.81$ )  
 8 Cryomodules

**1300 MHz 1.3-8.0 GeV**  
 19 Klystrons (ILC 10 MW MBK)  
 304 ILC-identical Cavities  
 38 ILC-like Cryomodules



~470 cavities

# Needed Processing Capability



- Fermilab has proposed that it would be like to be ready to build one beta = 1, 1.3 GHz cryomodule per month by 2012.
  - Fermilab also needs additional capacity for spoke (SSR1, SSR2 and TSR) and beta = 0.8 cavities
  - ~470 cavities are needed for this project in 4 years of production
  - Additional 10% would be processed that would never make in the accelerator (Failure)
  - Additional 10% would be processed as spare
- Total number of cavity processed will be ~570.
  - Assuming that each cavity on average will require 1.5 processing cycle
    - US capacity needed is (570+570+285) ~1425 processing installation total
    - Or ~340 processing installation/year
- This amounts to a needed capacity of
  - 570 bulk processing (~150 micron) (~120 per year)
  - 860 fine processing (~20 micron) (~220 per year)
  - 570 tuning and backing (~120 per year)
  - 860 vertical test (~220 per year)
- **This capacity is expected to be on the floor operation by 2012-13**

# Initial Proposal



- It would require considerable amount of work for the US laboratories to increase its acid handling capabilities to meet this demand by 2012
  - The environmental permit
  - The amount of acid handling
- One possible solution is
  - Fermilab gets US industry (ies) involved in doing bulk processing.
    - Similar to what is being done at XFEL
  - Upgrade the current US laboratories facilities
    - Fine processing (~20 micron)
    - Have redundancy in the system
  - Upgrade Fermilab facilities for
    - Tuning and Baking
    - Vertical Test
    - Post processing cleaning and assembly

# First US Industrial Facility



- In my opinion we do not have resources to start with 2 industry.
  - We should pick the one that has a greater chance of industrial success
- Initially pick one industry
- Install 2 processing stations like Jlab (or similar with industrial input)
  - Assuming that each station can do about 60 cycle/year
- Train this industry at Jlab and ANL in high gradient cavity processing technique
- Work out an working agreement so that laboratory and industrial personnel can work at each others facilities

# Upgrade of Laboratories Facility



- **The laboratories processing infrastructures will need upgrade to handle ~100 fine processing per year each facility.**
  - Acid volume and environmental permits should not be a problem as we have removed the bulk EP from labs.
  - Essentially we need to add another station of processing and HPR at Jlab and ANL.
- **What to do about BCP ?**
  - A decision is needed some time soon about the need of the BCP facility for the Spoke Resonators.
  - We have assembled a BCP facility at ANL but .....

# Needs Additional Facilities



- **Vertical Test**
  - Fermilab's plan for upgrading the vertical test facility augmented with Jlab's facility will meet the demand of Project-X
- **Tuning Machine**
  - We are in process of building one cavity tuning machine for 1.3 GHz cavity
  - An additional tuning machine would be needed
- **Oven**
  - Two 800 deg c
  - Three 120 deg c
- **HPR**
  - Two HPR at Jlab
  - One at ANL
  - Two at FNAL

# Eco-Friendly Processing



- In 2007 we initiated a discuss with Cabot Microelectronics to polish Nb using Semiconductor industry techniques.
- Initial sample has shown positive results.
- We have a PO established with them for polishing 1-cell cavity.
  - 3.9 GHz cavity has been polished. Communication problem, being redone again
  - Cabot has a 1-cell (1.3 GHz) cavity drawing that they are investigating how to polish
- Fermilab has purchased a cavity tumbling machine this needs installation, tooling and commissioning in collaboration with Cabot.
- If additional funds becomes available we could investigate another technique or vendor.